heat transfer—examples could be an integrated endothermic/exothermic reactor, vaporizer, recuperator, etc. Desirably, for heat transfer, a shim includes a first aperture and a second aperture whose shape conforms to that of the first aperture; examples include 2 wave-shaped apertures separated by a constant distance, a circle and an arc that surrounds a portion of the circle, and two triangular apertures arranged base-to-base.

[**0081**] Curved channels can have desirable characteristics in various laminated devices. The flow in a curved channel has a large velocity component near the wall towards the concave side. In the application of a fluid mixer, such as for a chemical reactor, a fluid phase separator, or drug distributor, this flow pattern also enhances the mixing process through higher mass transfer rate.

[**0082**] In a two-phase forced convection as in the microchannel condenser, the curved flow passage helps the transition from slug flow to a stratified or annular flow regime so as to form a separate vapor passage, as is shown in **FIG. 6***a*. However, in a straight flow channel, when channel gap size is decreased to a sufficiently small value, the capillary force will raise the liquid level to form a liquid bridge and block the whole channel so that the flow acquires a slug flow regime shown in **FIG. 6***b*. In slug flow, the capillary effect induces extra pressure drop and increases the thermal resistance of condensation by maintaining a relatively large and thick liquid film and lower vapor velocity. A main goal in condenser design is to rapidly remove the condensate from the surface and maintain the vapor-wall contact, a curved micro channel provides a better way to drive the liquid to one side and free the way for vapor in certain flow conditions and geometry.

[**0083**] Because a straight header or footer delivers non-uniform flow distributions or serious flow mal-distribution as well as undesired pressure drop profiles, performance can be improved by making the header and footer with varying cross section area. **FIG. 6***c* illustrates the cross-section of a laminated device that could be made by first forming shims comprising both zones A and B, such as by an ortho design with shims designed in the direction of flow and orthogonal to the page, and joined (such as by diffusion bonding) to curved headers (or footers) **604**, **606** which could be made by laminating identical shims, having curved apertures, in a non-ortho direction. The entrance head loss due to contraction and sharp turning from the header into the branch channels is reduced by the smooth channel entrance formed by curved shims. The curved header (or footer) **606** also provides flexibility to separately supply fluid to the channels of the heat exchanger where the heat load is significantly different from the other channels and different flow rate is required, especially when the space is constrained by other components. The curved channels can form a transition zone between a chemical reactor (in zone A for example) and a recuperator (zone B) that heats or cools the streams taking part in a reaction or recovers the heat in the product.

[**0084**] Laminated devices having ortho designs formed by apertures through shims with edge features on the aperture edge, that is, on the internal border formed by the edges of the aperture, can provide significant advantages over apertures without edge features. Apertures with edge features are shown in **FIGS. 9***a*-*9c*. An edge feature is a structure on the border of an aperture that causes at least a 0.1% variation, more preferably at least a 1% variation in the diameter of an aperture. For example, if the border of an aperture has a diameter of 1 cm and smooth edges except for a bump that sticks out 0.05 mm from the border, that bump is not an edge feature, but a 0.1 mm bump would be a feature. In some preferred embodiments, at least 20%, more preferably at least 50%, and in some embodiments at least 90%, or 100%, of the circumference of a border around an aperture is populated by edge features. Borders having 100% of their circumference populated by edge features **712**, **722** are shown in **FIGS. 9***a* and **9***b*. The edge features can have any shape, and could be, for example, squares (shown in **FIGS. 9***a* and **9***b*), triangles, circles, rectangles, etc. A particularly preferred shape is illustrated in **FIG. 9***c* which shows protuberances in which the cross-sectional diameter of the base (attached to the border) is narrower than the cross-sectional diameter of a part of the protuberance that protrudes from the edge of the (average diameter of the) aperture. The shims with apertures having edge features can be stacked together with each feature adjacent a corresponding feature to form a channel or groove (see **FIG. 9***b* for example) or stacked adjacent shims without corresponding features to form protuberances on a channel (or chamber) wall (see **FIG. 9***a* for example).

[**0085**] In single phase mass and heat exchangers, the corrugated surface formed from the shims shown in **FIG. 9***a* breaks down the thermal boundary layer development in laminar flow, forms the zone of large temperature gradient (thinned boundary layer) and in turn enhances the mass and heat transfer process. In the turbulent flow regime, this structure increases the turbulent mixing. An increased heat transfer area is characterized by the structured micro channel surface.

[**0086**] In flow boiling heat exchangers, the formation of vapor bubbles on a smooth surface of a microchannel causes a high potential of developing hot spots at high quality due to dryout of the thin liquid film underneath the vapor bubble. A structured channel surface made from shims shown in **FIG. 9***a* reduces the chance of this problem through the enhanced liquid supply to the bubble bottom, as is depicted in **FIG. 9***c*. The microstructure of the grooves and the corrugations increases the liquid flow towards the bubble bottom driven by capillary force. A protrusive structure, such as in **FIG. 9***c*, increases the solid wall area underneath the bubble and in the contact area with the liquid, as such the evaporation process is more efficient than a smooth surface. Thus, overall heat transfer is significantly enhanced with lower wall temperature and higher heat flux than that obtained with a smooth surface.

[**0087**] In another preferred embodiment, the invention provides a laminated device that includes a static mixer such as those illustrated in **FIGS. 8***a* and **8***b*. **FIG. 8***a* shows three shims **802**, **804**, and **806**. Each shim has an aperture **808** that is divided in half by a strip **812**. The illustrated shims show a centrally located strip; however it should be appreciated that the strip could be any protuberance in the aperture and need not be centrally located. For good mixing, any protuberance should project at least 5% across the diameter of the aperture. The protuberance(s) (including strip(s)) should be in different locations on at least 3 shims that are bonded together such that the apertures form a flow path. Preferably, the at least 3 shims should be adjacent. **FIG. 8***b* illustrates another mixer **820** in which a mixing insert, such as spring